Space Weather Technical Forecast

Issued on Wednesday, 24 April 2024 at 12:10 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Further M-class flares expected (R1/R2 blackouts). Chance of isolated G1/Minor Storm intervals from peripheral CME effects. A coronal hole high-speed stream is likely to arrive by day 3 (26 Apr).

Solar Activity: Moderate with four M-class flares observed in the past 24 hours, the largest observed, peaked at M2.9 at 23/1733 UTC from AR3635 in the southwest. There are currently fifteen sunspot regions on the visible disc, two of which are unnumbered. This includes a broad cluster of regions in the southwest; which include AR3638/45/47/43. These regions carry a large percentage of the current flare risk, with the spots magnetically connected and continue to show magnetic complexity, especially with AR3643, which consists of a delta configuration. Several other regions are also moderately sized, but generally these remain more stable with simpler bipolar configurations. However, AR3654 in the southeast continues to show some minor growth in its trailing portion. AR3646 has recently shown some minor decay in its intermediate spots since previous analysis. Meanwhile, AR3650 in the southwest has faded.

Multiple CMEs observed in available imagery over the previous 24hrs, although limited clear Earth-directed potential. The most likely candidates are a recent CME associated with a M1.6 flare from AR3638 at 22/2116UTC, associated with a 395km/s Type II radio emission, perhaps bringing a glancing blow on day 4 (27 Apr). We await model output and further analysis of the CME associated with the M3.0 flare from the AR3638 region in the southwest at 23/1710UTC and likely associated Type II radio burst.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 were slightly elevated to background throughout, on a steady trend, currently near 370km/s. Below average density throughout. The Interplanetary Magnetic Field (IMF) Bt, was weak 3 to 6nT, with the north-south component, Bz, varying weakly between -6/+6nT. Phi angle was predominately negative (towards the Sun), before recently re-orientating to become mostly positive (away from the Sun). Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was at Background. High energy electron flux (greater than 2MeV) observed at GOES16 was generally Moderate throughout. The associated 24-hour fluence remained below Active (1e8 integrated flux), but with a rising trend, reaching 3.13e7 integrated pfu at 24/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Occasional M-class flares are expected to continue, with a slight chance of isolated X-class flares. The greatest risk from the large complex of sunspots in the southwest.

Solar Wind / Geomagnetic Activity: There are several CMEs that are anticipated to pass close to the Earth through the period, with potential of glancing interactions. This gives low confidence to the detail for the geomagnetic forecast. Solar winds have eased to slow-ambient levels, and in the absence of CME influence should continue at similar levels to start the period. A further

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enhancement likely by day 3 (26 Apr) however, in association with CH27/+ near centre disc, likely seeing winds increasing back towards slightly elevated or elevated levels though into day 4 (27 Apr).

Overall, geomagnetic activity expected to be mostly Quiet initially, with Unsettled intervals. However, any glancing CME arrivals will give a chance of Active intervals and a slight chance of G1/Minor Storms, this risk peaks into day 2 (25 Apr). Activity perhaps more generally increasing by later day 3 (26 Apr) with Unsettled to Active conditions expected by the end of the period given positive coronal hole and HSS influence.

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain at background levels, but with a chance of rising in response to any large flares that occur, predominately from the complex of sunspots in the southwest. This bringing a slight chance of reaching the S1 Minor Radiation Storm threshold throughout.

High energy electron flux as observed by GOES16 is expected to display a slowly rising trend, increasingly Moderate and likely peaking at High diurnal values early in the period, however this may be limited by any glancing CME impacts that occur. The associated 24-hour electron fluence is expected to remain generally below the Active (1e8 integrated pfu) threshold but with a rising trend, giving an increasing chance of reaching the Active threshold into day 2 (25 Apr) but reducing thereafter.

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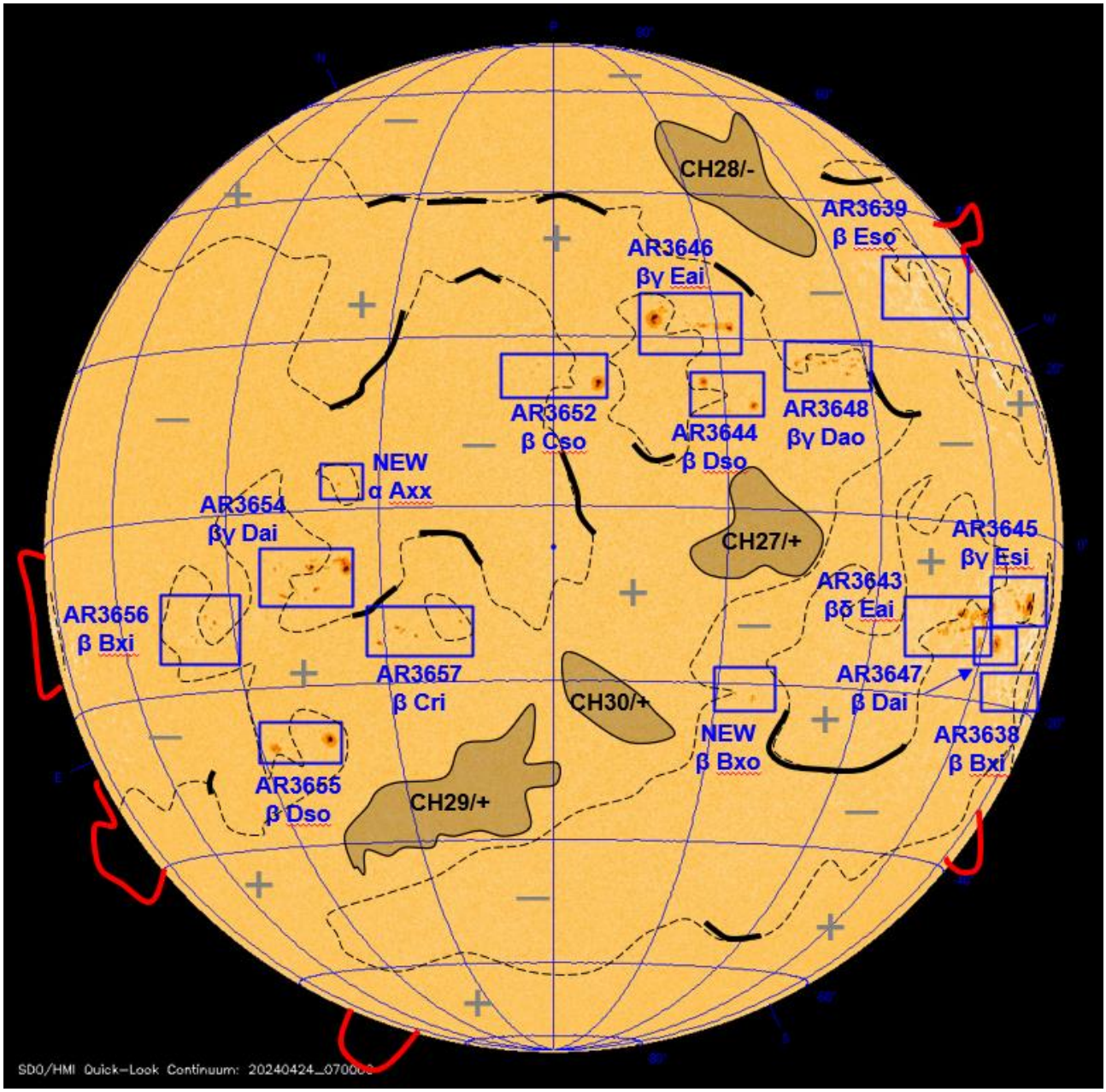
Figure 1. Solar Analysis Valid 24/0700 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Multiple CMEs associated with the complex sunspot region in the southwest have been observed in recent days, including a recent CME associated with a M3.0 flare at 23/1710UTC from AR3638 and type II radio burst for which we await model output. Analysis suggests CMEs may pass close to Earth through the period, largely glancing to the south. These CMEs may be too weak for much of a noticeable impact, but there is the potential for an increase in geomagnetic activity from any glances that occur, particularly through day 2 (25 Apr).

Otherwise solar winds have eased to slow-ambient wind conditions in the absence of CME and HSS enhancement. A further enhancement likely by day 3 (26 Apr) however, in association with CH27/+ currently near centre disc, likely seeing winds increasing to slightly elevated or elevated levels into day 4 (27 Apr).

Overall, geomagnetic activity expected to remain mostly Quiet initially, with Unsettled intervals. However, any CME arrivals will give a chance of Active intervals and a chance of G1/Minor Storms, this risk peaks into day 2 (25 Apr). Activity perhaps more generally increasing by later day 3 (26 Apr) into day 4 (27 Apr) with Unsettled to Active conditions, with a chance of G1/Minor Storm by the end of the period given positive CH and HSS influence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	25	30	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Multiple CMEs associated with the complex sunspot region in the southwest have been observed in recent days. Analysis suggests CMEs may pass close to Earth through the period, largely glancing to the south.

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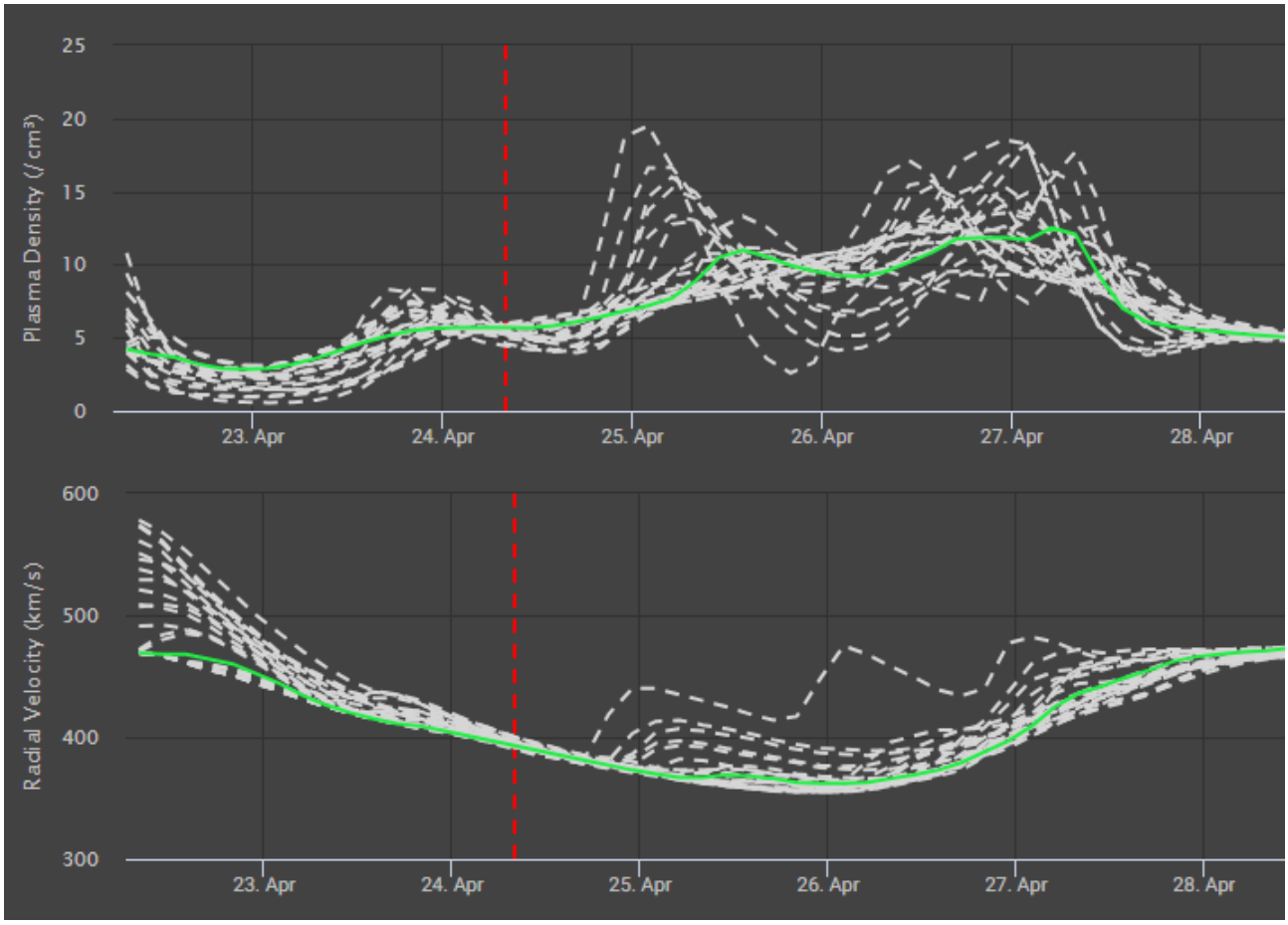
Figure 2: MOSWOC ENLIL Ensemble – showing possible multiple glancing blows during the period, especially from day 2 (25 Apr).



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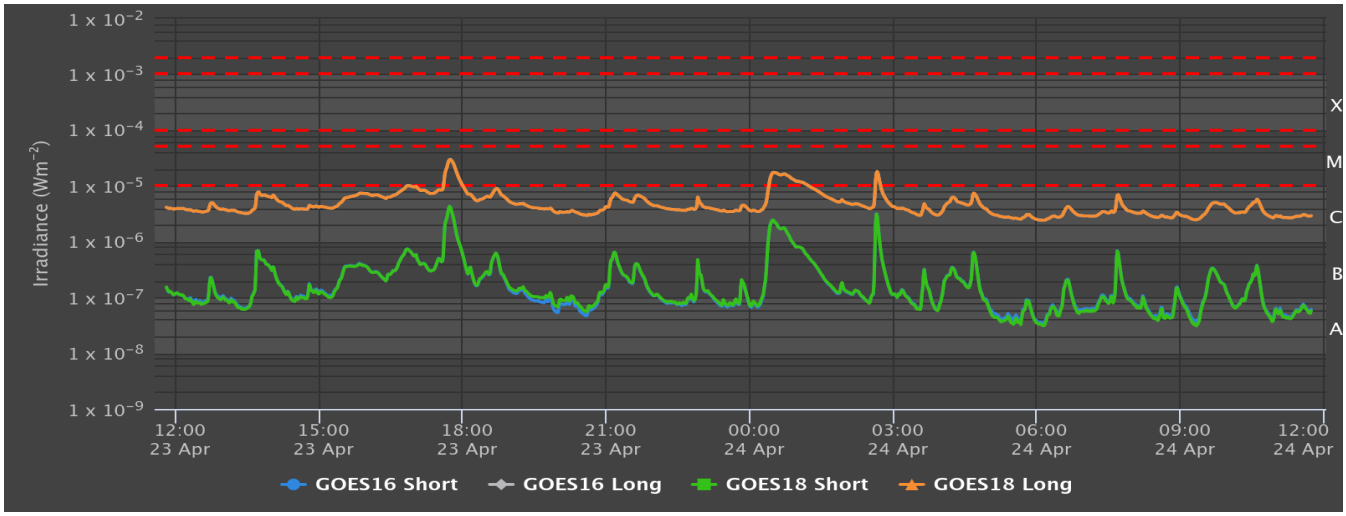
Radio Blackouts - X-Ray Flares:
Moderate activity is expected to continue through this guidance period, with occasional M-class flares expected and a slight chance of isolated X-class flares.

There are currently fifteen sunspot regions on the visible disc, two of which are unnumbered. This includes a broad cluster of regions in the southwest; which include AR3638/45/47/43. These regions carry a large percentage of the current flare risk, with the spots magnetically connected and continue to show magnetic complexity, especially with AR3643, which shows a delta configuration at present. Several other regions are also moderately sized, but generally these remain more stable with simpler bipolar configurations. However, AR3654 in the southeast continues to show some minor growth in its trail portion. AR3646 has recently shown some minor decay in its intermediate spots since previous analysis. Meanwhile, AR3650 in the southwest has faded.

The cluster of regions in the southwest will approach and begin to round the western limb through day 3 (26 Apr) but will likely continue to present a flare risk throughout the period depending on further developments. With no significant returning regions expected during the period, or currently signaled on far side sounding data to counter balance the loss of flare potential, a general reduction in the flare risk is likely, but not until perhaps the very end of the forecast period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES X-Ray flux trace



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux as observed by GOES18 has persisted at Background. There remains a slight chance of enhanced flare activity, primarily from the cluster of sunspot in the southwest disc, which could increase the proton flux at Earth. This brings a slight chance of reaching the S1 Minor Solar Radiation Storm level throughout the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux as observed by GOES16 rose to persistent Moderate levels during 22 Apr, likely as a result of the recent CME arrival and HSS onset that had been observed on previous days. As solar winds likely continue to slowly ease, any charging that has occurred at lower L-shells is expected to become increasingly relevant at GEO, with the observed flux increasingly likely peaking at High levels during diurnal maxima into days 1 and 2 (24-25 Apr). This is only moderate confidence however, as the arrival of any CMEs and associated geomagnetic activity may help to modulate the observed flux, and any more notable arrivals have the potential to drop values back towards Background. Expected HSS influence by days 3 and 4 (26-27 Apr) will also likely bring a similar reduction in flux values back towards Background levels.

The associated 24 hour electron fluence is thus expected to continue on a generally upward trend in the near term, as indicated by Met Office REFM output, which looks to be providing reasonable guidance in the absence of any CME arrivals, but likely under-estimating peak values. This will give an increasing chance of reaching the Active threshold by day 2 (25 Apr), although this potential will reduce should any dropout from any CME arrival occur and remains only moderate confidence, and reduces by the end of the period given potential HSS influence.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	30	30	20	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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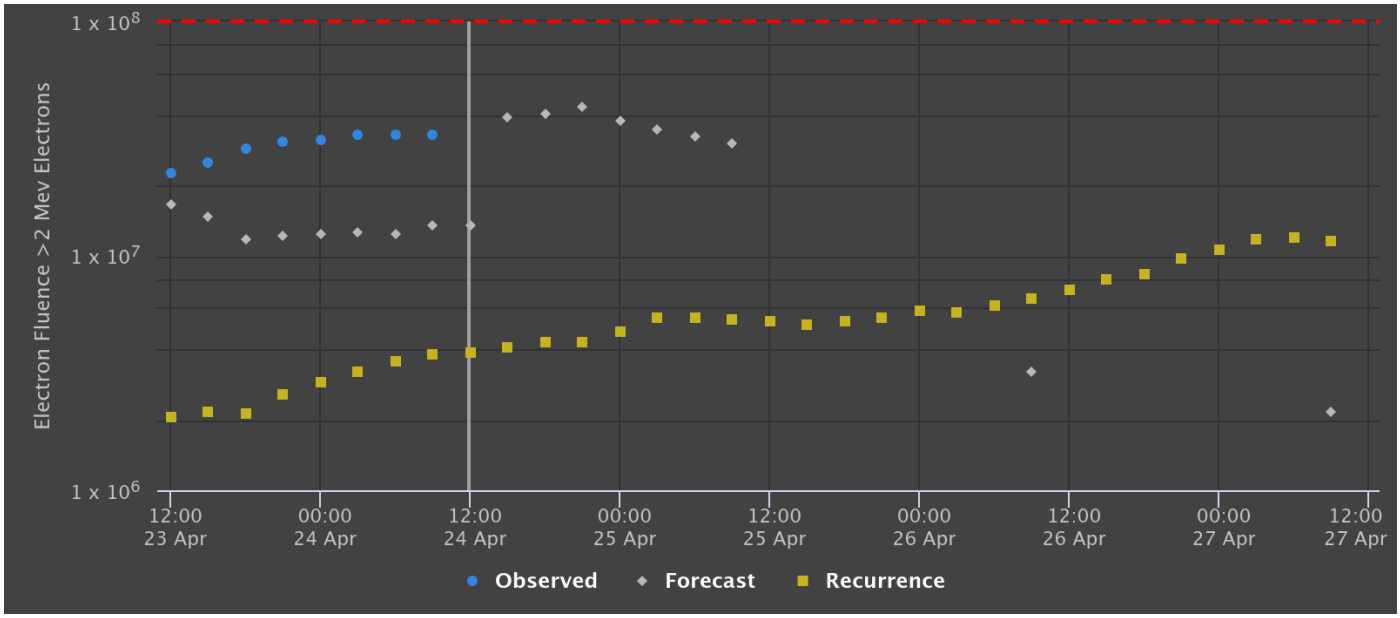
Figure 4: MOSWOC REFM output – electron fluence



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